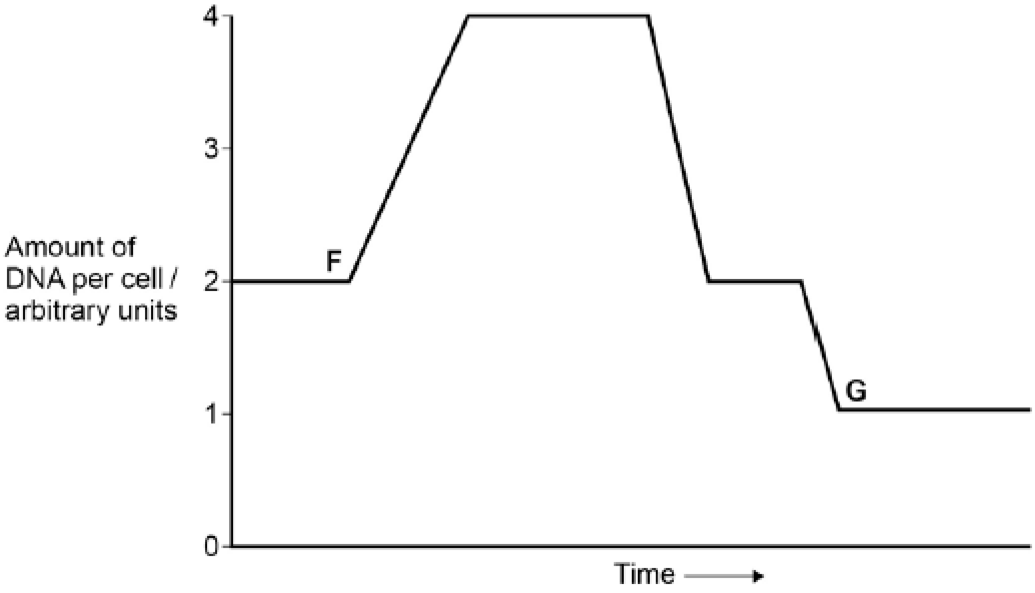
TOPIC 4
Genetic Diversity & Species Diversity
Pack 1

A Level Yr1/AS

Q1. The figure below shows how the amount of DNA per cell changed during interphase and meiosis in an animal.



(a) Explain how the behaviour of chromosomes causes these changes in the amount of DNA per cell between **F** and **G**.

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(Extra space) ....

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(3)

(b) What would happen to the amount of DNA per cell at fertilisation of cell **G?**

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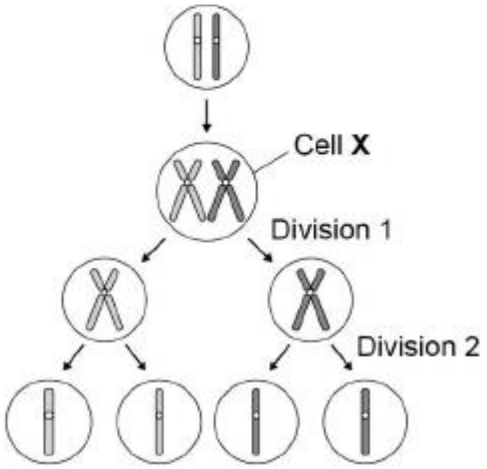
(1)
(Total 4 marks)

Q3. The figure below summarises the process of meiosis. The circles represent cells and the structures within each cell represent chromosomes.



(a) Describe and explain the appearance of **one** of the chromosomes in cell **X**.

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(Extra space) ....

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(3)

(b) Describe what has happened during division 1 in the figure above.

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(2)

(c) Identify **one** event that occurred during division 2 but **not** during division 1.

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(1)

(d) Name **two** ways in which meiosis produces genetic variation.

1 ....

2 ....

(2)
(Total 8 marks)

Q5. Division of the nucleus by meiosis produces haploid cells from a diploid cell. Nuclei produced by mitosis have the same number of chromosomes as the parent nucleus.

(a) What is the biological importance of reducing the chromosome number when the cell divides by meiosis?

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(2)

(b) The table gives one difference between meiosis and mitosis. Complete the table by giving **three** further differences.

	Meiosis	**Mitosis**
1	Reduces the chromosome number	Maintains the same chromosome number as in the parent nucleus
2		
3		
4		

(3)
(Total 5 marks)

Q7. Two pairs of alleles **A** and **a**, and **B** and b are found on one pair of homologous chromosomes. A person has the genotype **AaBb**. **Figure 1** shows the chromosomes at an early stage of meiosis. The position of two of the alleles is shown.

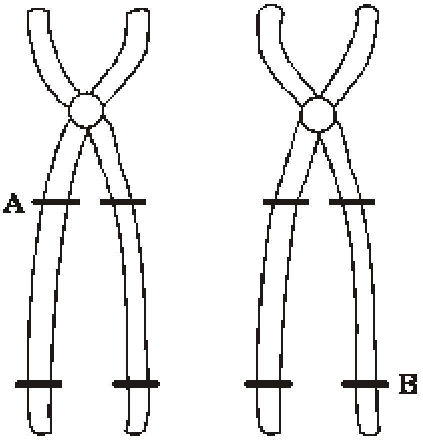

Figure 1

(a) Complete **Figure 1** to show the alleles present at the other marked positions.

(1)

Crossing over occurs as shown in **Figure 2**.

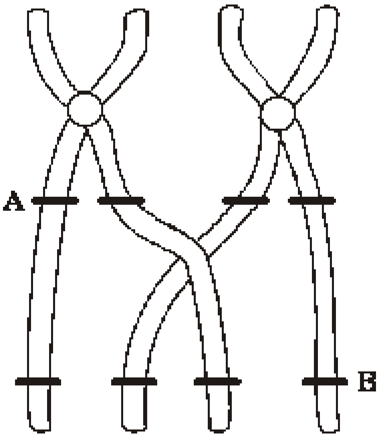

Figure 2

(b) What term is used to describe the pair of homologous chromosomes shown in **Figure 2**?

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(1)

(c) From **Figure 2**, give the genotypes of the gametes produced containing the chromatids

(i) that have **not** crossed over;

....

(ii) that have crossed over.

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(2)

(d) Give **two** processes, other than crossing over, which result in genetic variation. Explain how each process contributes to genetic variation.

Process ....

Explanation ....

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(2)

Process ....

Explanation ....

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(2)

(Total 8 marks)

Q9. (a) During meiosis, one chromosome from each homologous pair goes to each of the cells produced. Explain why this is important.

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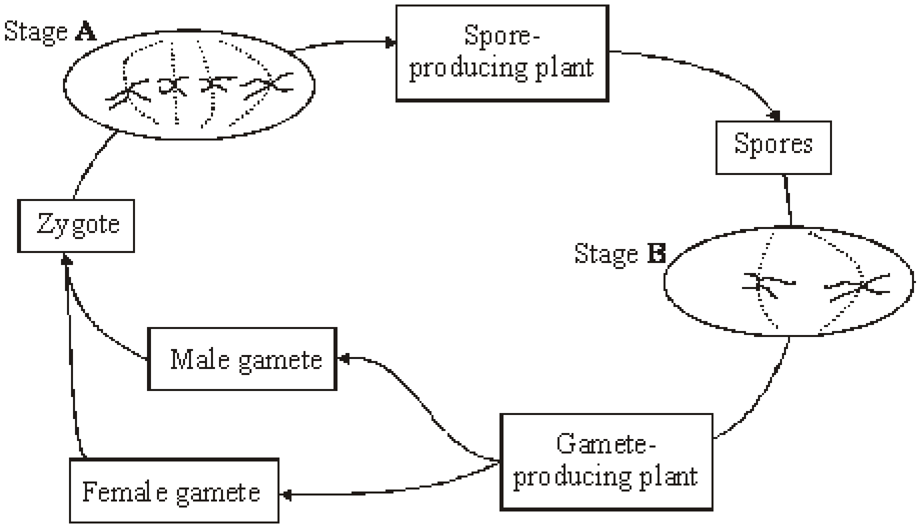
(2)

(b) The diagram shows the life cycle of a fern plant. Drawings of the chromosomes during cell division are shown for the stages that give the spore-producing plant and the gamete-producing plant.



(i) What is the diploid number of chromosomes in this fern plant?

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(1)

(ii) Explain the difference in the number of chromosomes at stages **A** and **B**.

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(1)

(iii) Are the male and female gametes produced by mitosis or meiosis?

Explain your answer.

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(2)

(Total 6 marks)

Q11. **Figure 1** and **Figure 2** show the chromosomes from a single cell at different stages of meiosis.

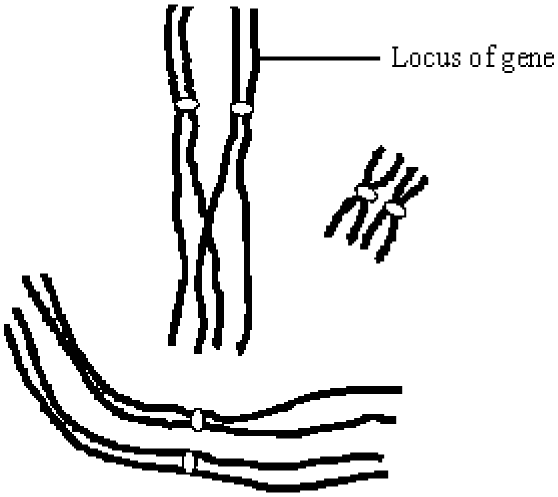

Figure 1

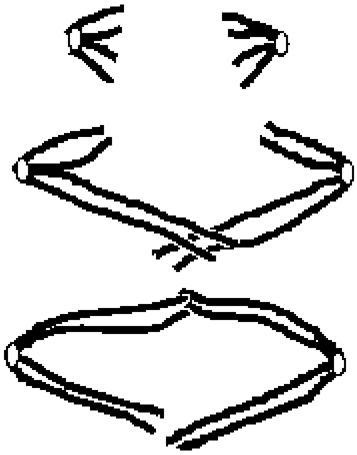

Figure 2

(a) What is the diploid number of chromosomes in the organism from which this cell was taken?

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(1)

(b) Describe what is happening to the chromosomes at the stage shown in

(i) **Figure 1**;

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(2)

(ii) **Figure 2**.

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(2)

(c) (i) The genotype of this organism is **Bb**. The locus of this pair of alleles is shown in **Figure 1**.

Label **two** chromosomes on **Figure 2** to show the location of the **B** allele and the location of the **b** allele.

(1)

(ii) How many genetically different gametes can be produced by meiosis from a cell with the genotype, **Bb Cc Dd**? Assume these genes are located on different pairs of homologous chromosomes. Show your working.

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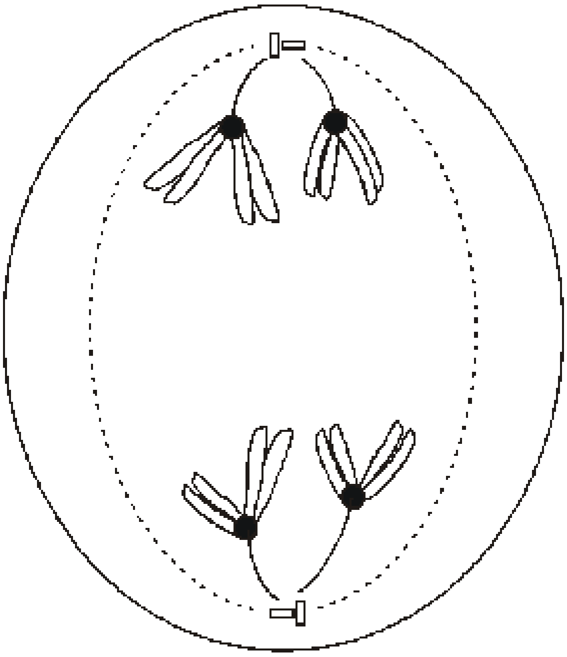
(2)
(Total 8 marks)

Q13. (a) The diagram shows a cell undergoing cell division.



Identify the type and stage of cell division shown. Give evidence from the diagram to support your answer.

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(3)

(b) Describe how crossing over occurs during meiosis I.

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(2)
(Total 5 marks)

Q15. (a) Name **one** mutagenic agent.

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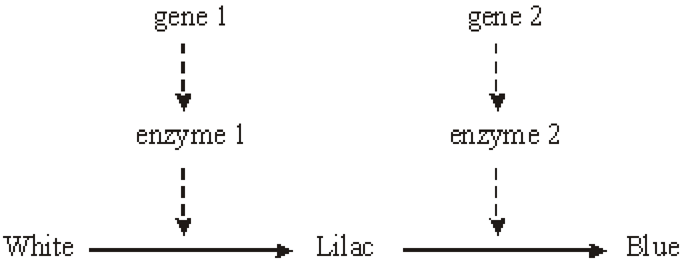
(1)

(b) In flax plants the flowers are white, lilac or blue. The diagram shows the pathway by which the flower cells produce coloured pigments.



(i) A deletion mutation occurs in gene 1. Describe how a deletion mutation alters the structure of a gene.

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(2)

(ii) Describe and explain how the altered gene could result in flax plants with white-coloured flowers.

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(4)

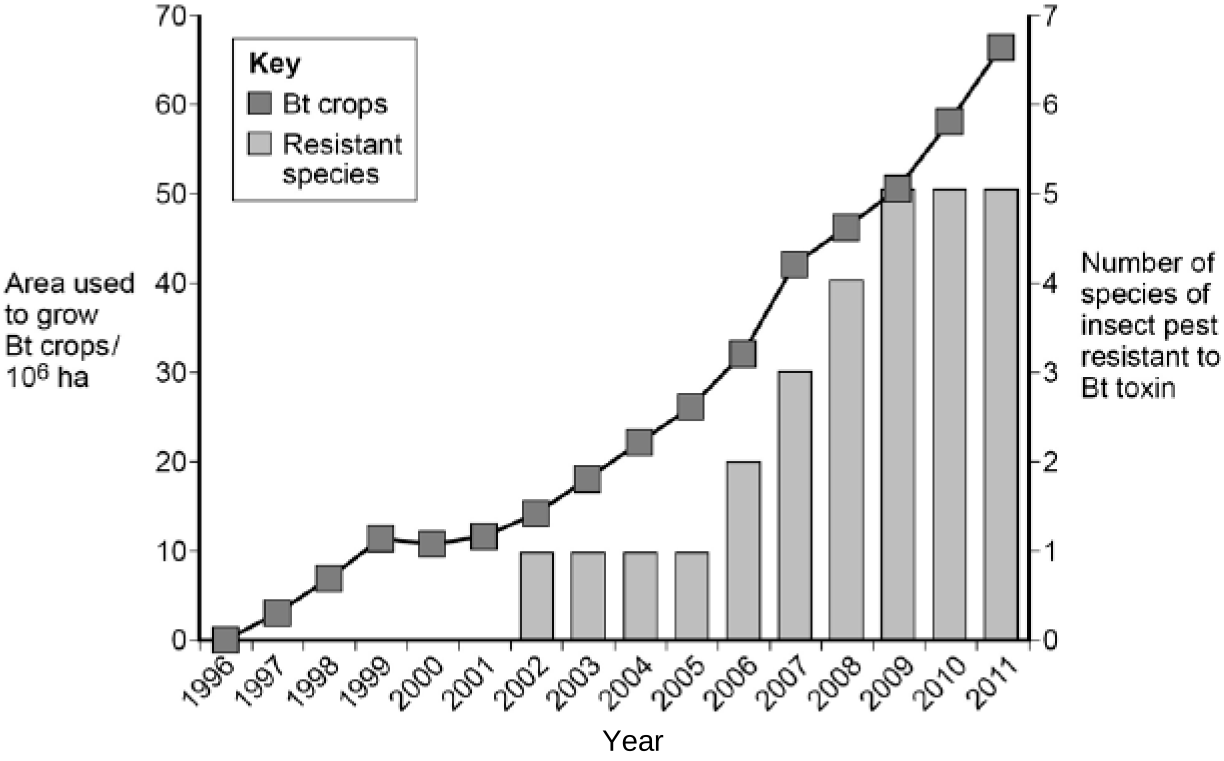
(Total 6 marks)

Q17. To reduce the damage caused by insect pests, some farmers spray their fields of crop plants with pesticide. Many of these pesticides have been shown to cause environmental damage.

Bt plants have been genetically modified to produce a toxin that kills insect pests. The use of Bt crop plants has led to a reduction in the use of pesticides.

Scientists have found that some species of insect pest have become resistant to the toxin produced by the Bt crop plants.

The figure below shows information about the use of Bt crops and the number of species of insect pest resistant to the Bt toxin in one country.



(a) Can you conclude that the insect pest resistant to Bt toxin found in the years 2002 to 2005 was the same insect species? Explain your answer.

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(1)

(b) One farmer stated that the increase in the use of Bt crop plants had caused a mutation in one of the insect species and that this mutation had spread to other species of insect. Was he correct? Explain your answer.

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(Extra space) ....

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(4)

(c) There was a time lag between the introduction of Bt crops and the appearance of the first insect species that was resistant to the Bt toxin.
Explain why there was a time lag.

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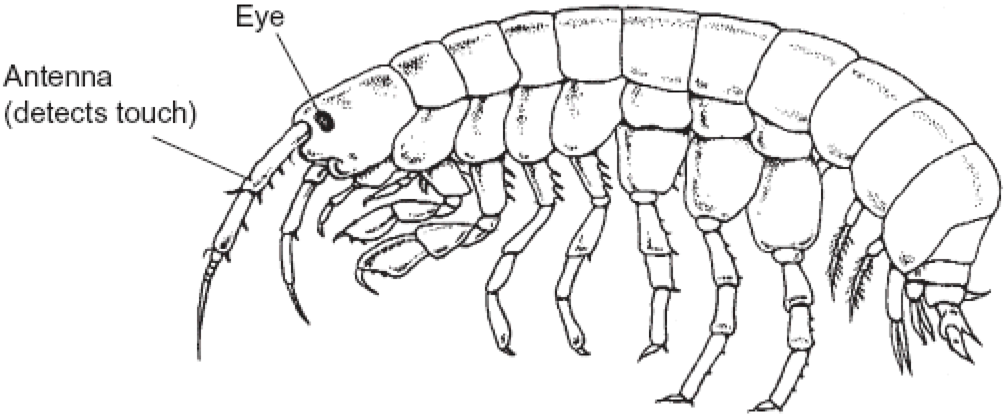
(3)
(Total 8 marks)

Q19. **Figure 1** shows a fresh-water shrimp.

Figure 1



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.

They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

	Shrimps from the stream	
	Inside the cave	In the open
Mean diameter of eye /mm	0.09	0.24
Mean length of antenna /mm	8.46	5.81

(a) The biologists measured the maximum diameter of each shrimp's eye.

Explain why they measured the **maximum** diameter.

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(1)

(b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

(i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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(2)

(ii) The data in **Figure 2** are mean values. Explain how standard deviations of these cmean values would help you to interpret the data in **Figure 2**.

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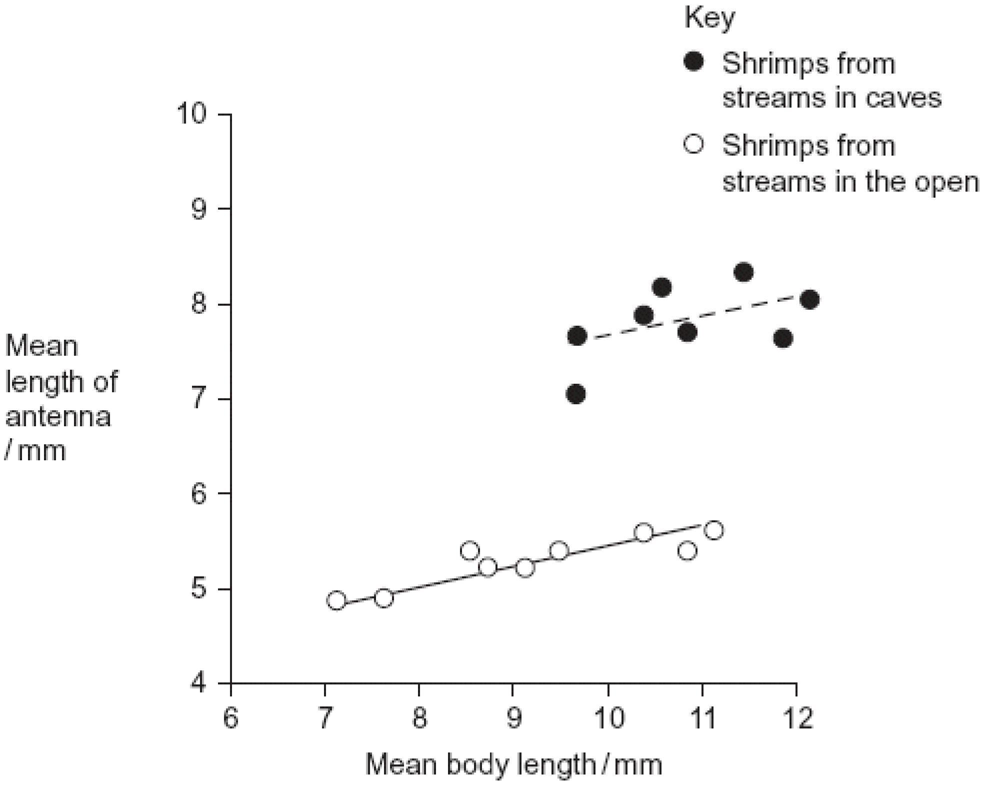
(2)

(c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

Figure 3



(i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

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(2)

(ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

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(1)

Other biologists investigated the genetic diversity of these shrimps. **Figure 4** shows some of the data they collected.

Figure 4

Gene	**Allele**	**Percentage of shrimps with this allele in steam**	
		Inside a cave	**In the open**
PGI	**A**	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	**J**	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

(d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

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(1)

(e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3)

(f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

(i) Describe how the biologists should carry out these breeding experiments.

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(ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

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(3)
(Total 15 marks)

Q21. (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

(i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

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(2)

(ii) Suggest why older people are more likely to be affected by *C. difficile*.

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(1)

(b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

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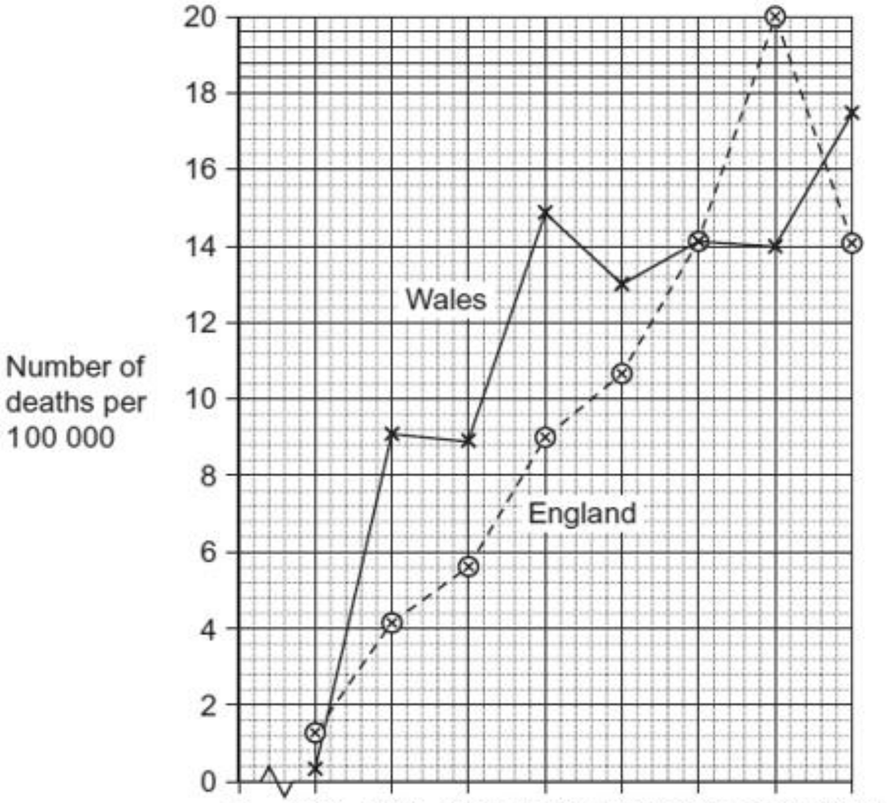
(2)

(c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



(i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

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(1)

(ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

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(1)

(iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

Answer ....

(2)

(Total 9 marks)

Q23. (a) The number of patients infected with the bacterium MRSA has increased in some hospitals. Scientists have suggested ways to reduce the transmission of MRSA in hospitals. Suggest **two** ways to reduce the transmission of MRSA in hospitals.

1 ....

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2 ....

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(2)

(b) The minimum inhibitory concentration (MIC) is the lowest concentration of a substance that prevents the growth of a microorganism.

When antibiotics are prescribed for treating patients, higher doses than the MIC are recommended. Suggest **two** reasons why.

1 ....

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2 ....

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(2)

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

	Minimum inhibitory concentration / μg cm^{-3}			
Drug	*Escherichia coli*	*Staphylococcus aureus*	*Enterococcus faecalis*	*Pseudomonas aeruginosa*
P	0.39	0.049	0.049	3.13
Q	1.54	0.049	0.195	3.13
R	0.39	0.049	0.195	1.56
S	1.56	0.098	0.390	12.50

(c) Which of the four drugs is

(i) most effective against *Enterococcus faecalis*?

☐

(1)

(ii) least effective against all the species of bacteria used?

☐

(1)

(d) The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

(i) Suggest **two** ways in which a double-blind trial improves reliability.

1 ....

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2 ....

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(2)

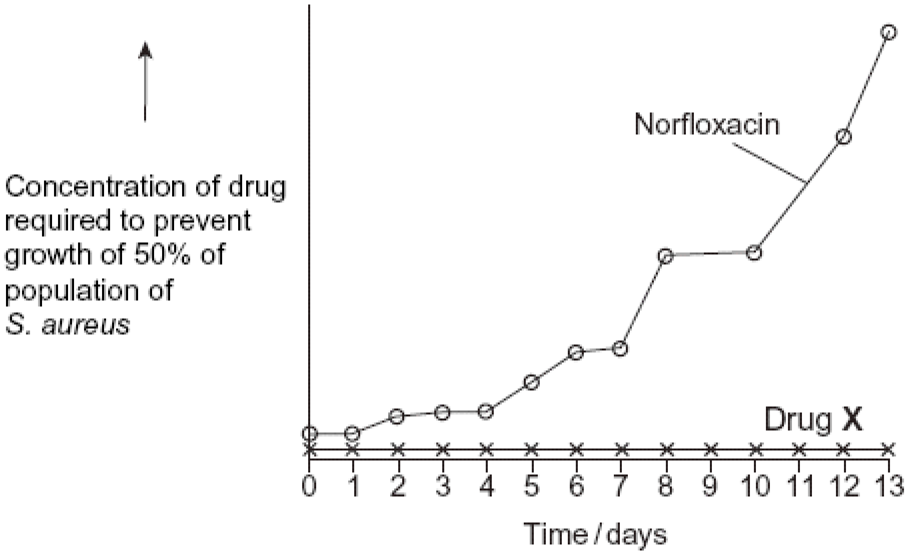
(ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1 ....

2 ....

(2)

(e) Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They tested the sample to find the concentration of Norfloxacin that prevented the growth of 50 % of the bacteria in the sample.
The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug **X**. The results of both investigations are shown in the graph.



Describe the results obtained with Norfloxacin.

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(1)

(Total 11 marks)

Q25. (a) Some antibiotics bind with specific receptors in the plasma membranes of bacteria. The structure of these receptors is determined genetically. Bacteria can become resistant to an antibiotic because a gene mutation results in an altered receptor.

Explain how resistance to an antibiotic could become widespread in a bacterial population following a gene mutation conferring resistance in just one bacterium.

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(5)

(b) Some humans have a genetic resistance to infection. A recessive allele gives increased resistance to infection by the malarial parasite. In a population, the proportion of babies born who are homozygous for this allele is 0.01. Use the Hardy-Weinberg equation to calculate the expected proportion of heterozygotes in this population. Show your working.

Answer ....

(4)
(Total 9 marks)

Q27. Finches are small birds. Fourteen species of finch are found on the Galapagos Islands.

(a) What is a species?

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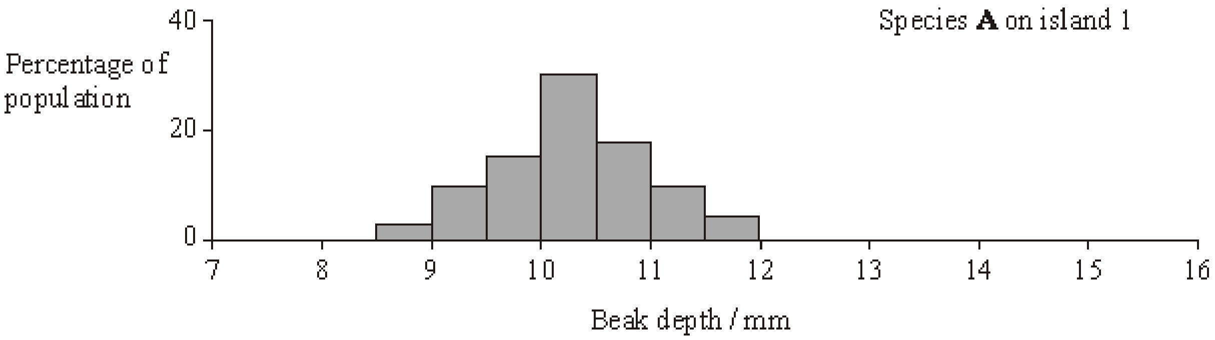
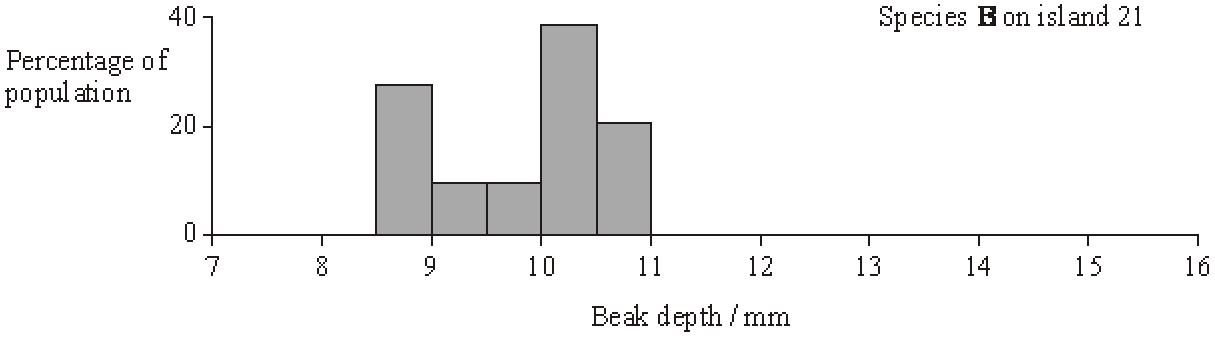
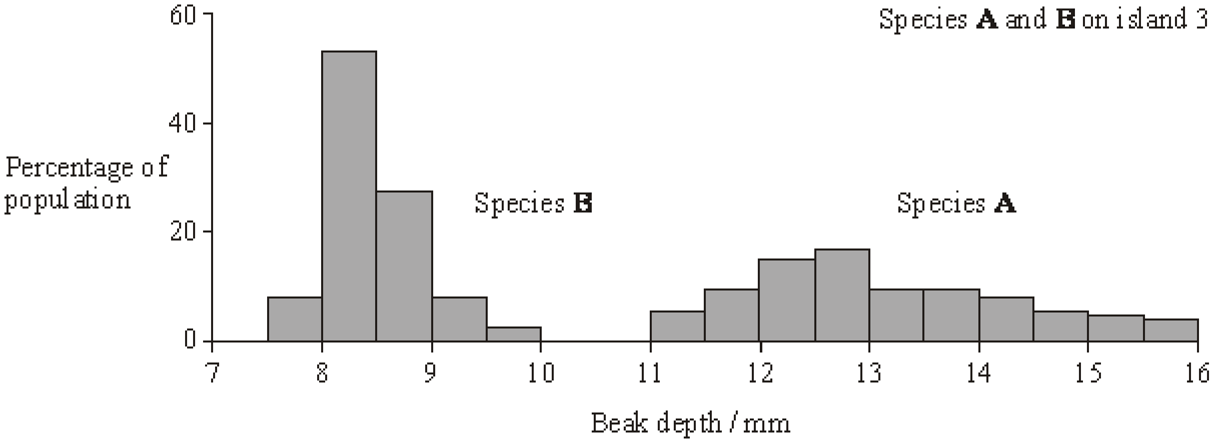
(2)

(b) Measurements were made of the beak depth of two species of finch (species **A** and species **B**) on different islands. Species **A** is found on island 1, species **B** is found on island 2. Both species are found on island 3. They are thought to have colonised island 3 from islands 1 and 2 respectively. The graphs show the ranges of beak depths of the two species on the different islands.







What type of natural selection took place in the populations of both species after they had colonised island 3? Explain your answer.

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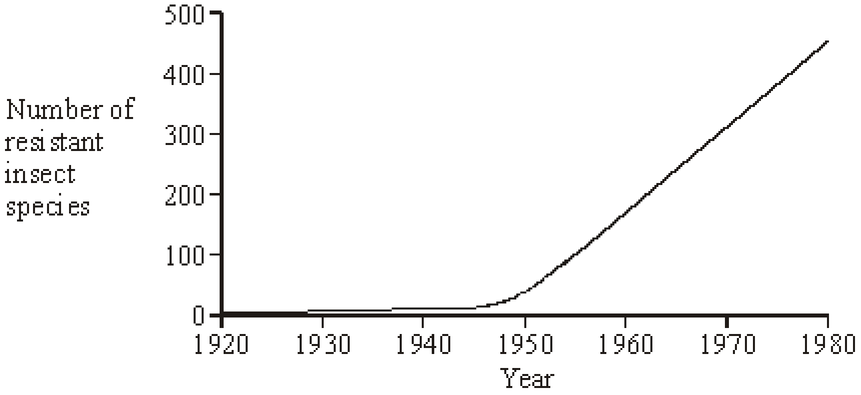
(3)
(Total 5 marks)

Q29. The graph shows the number of species of insects reported to be resistant to at least one insecticide between 1920 and 1980.



(i) Suggest **one** reason why there was a rapid rise in resistant species after 1950.

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(1)

S (ii) Explain how an insect population can become resistant to an insecticide.

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(3)
(Total 4 marks)

Q31. In an attempt to control the huge numbers of an insect pest, low doses of a pesticide were sprayed on a lake. After spraying, the concentration of pesticide in the lake water was 14 parts per billion. After spraying, diving birds which fed on small fish in the lake were found to be dying. The concentration of the pesticide in these birds was more than 1 part per thousand.

S (a) The lake was sprayed three times. The first spraying killed almost all of the insects, as did a second application five years later. When the lake was treated for a third time it was found that some insects were resistant to the pesticide.

Explain how resistance to the pesticide evolved in the insect population.

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(3)

S (b) This pesticide is able to pass easily through cell membranes. Suggest why.

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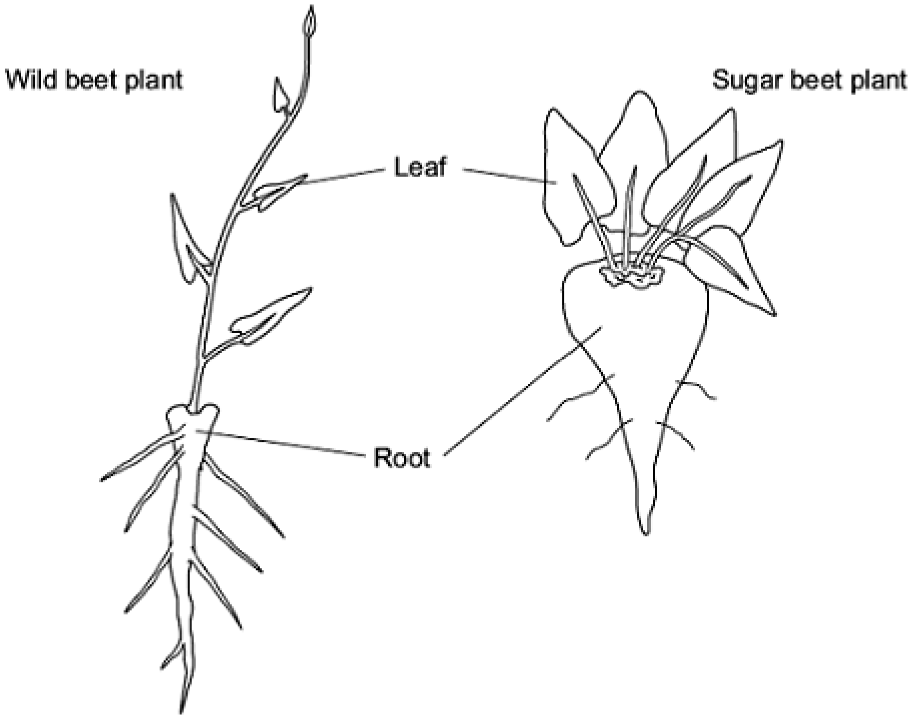
(2)

(Total 5 marks)

Q33. Sugar beet is a crop grown for the sugar stored in its root. The sugar is produced by photosynthesis in the leaves of the plant. Plant breeders selected high-yielding wild beet plants. They used these plants to produce a strain of sugar beet to grow as a crop.

The drawings show a wild beet plant and a sugar beet plant. The drawings are to the same scale.



(a) Use the drawings to describe **two** ways in which a sugar beet plant is different from a wild beet plant.

Explain how each of these differences would give an increased yield of sugar.

Difference 1 ....

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Explanation ....

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Difference 2 ....

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Explanation ....

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(4)

(b) Sugar beet plants have been selected for a faster rate of growth.

Suggest how the faster rate of growth may increase profit for a farmer.

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(1)

(c) Describe and explain how selection will have affected the genetic diversity of sugar beet.

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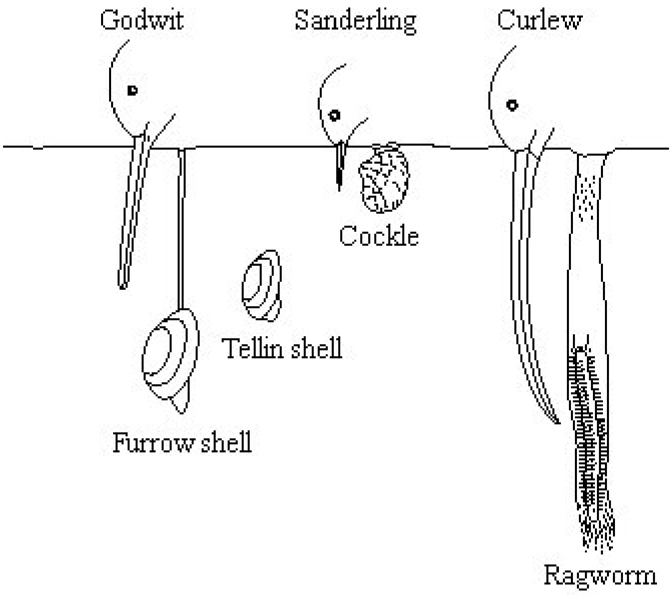
(2)
(Total 7 marks)

Q35. Some birds feed on animals found in mud in estuaries. The drawing shows the heads of three species of these birds and their prey.



(a) Use the information in the drawing to explain how interspecific competition between the birds is reduced.

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(2)

(b) Explain how competition might have played a part in the evolution of the long curved beak of the curlew.

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(4)

(c) Mud higher up the shore receives fresh water draining from the land. Ragworms are able to survive in this mud because they can tolerate the absorption of water into their tissues. Explain what causes a ragworm to absorb water when higher up the shore.

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(2)
(Total 8 marks)

M1.(a) (Increase)

1. Chromosomes / DNA replicates;
   (First decrease)
2. Homologous chromosomes separate;
   (Second decrease)
3. Sister chromatids separate;

3

(b) 1. (DNA would) double / go to 2 (arbitrary units);

1

[4]

M3.(a) 1. Chromosome is formed of two chromatids;

2. (Because) DNA replication (has occurred);
3. (Sister) chromatids held together by centromere;

3

(b) 1. Chromosomes in homologous pair;

2. One of each into daughter cells / haploid number;

2

(c) Separation of (sister) chromatids / division of centromere;

1

(d) 1. Independent segregation (of homologous chromosomes);
Accept random assortment

2. Crossing over / formation of chiasmata;

2

[8]

M5. (a) Later fertilisation / cell fusion; (NOT just ‘sexual reproduction’)
Restoring diploid / original number / not doubling chromosome number;
ALLOW ref ‘½ + ½’

2

(b) Any three pairs from:

need comparison of meiosis and mitosis each time

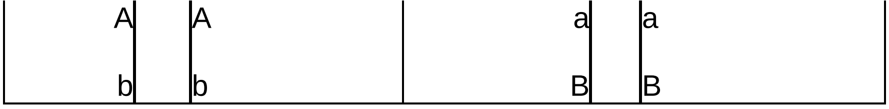
Meiosis	Mitosis
(Homologous) chromosomes associate in pairs	(Homologues) independent / do not pair (IGNORE ref. separation
Crossing-over / chiasmata formation	No crossing-over;
Two / (nuclear stages) divisions / → 4 offspring cells	One / (nuclear stage) division / → 2 offspring cells;
Genetically different (product)	Genetically identical (product);

IGNORE refs. To location

max 3

[5]

M7. (a)



1

(b) bivalent;

1

(c) (i) Ab, aB;

(ii) AB, ab;

2

(d) mutation;
different / new allele formed / genes deleted or duplicated / sequence of genes changed *(reject genetic information)*;
random fusion of gametes / fertilisation;
new combination of alleles;
independent assortment (of chromosomes) *(accept random)*;
shuffling of maternal and paternal chromosomes / new combination of alleles;
(ignore references to stages of meiosis)
any 2 × 2

4 max

[8]

M9. (a) to get haploid / n / half number of chromosomes (in cells);
so that each cell gets one copy of each chromosome / gene / full set of genes / so that fertilisation produces diploid / constant chromosome number; results in independent assortment;

2

(b) (i) 4;

1

(ii) meiosis (has halved the chromosome number);

1

(ii) (mitosis because) zygote gets two chromosomes from each gamete / has four chromosomes;

accept haploid for two and diploid for four

gamete-producing plant has two chromosomes,
so mitosis to produce gametes with two;

2

[6]

M11. (a) 6;

1

(i) chromosomes are arranged in (homologous) pairs / bivalents;
crossing over / chiasma present / exchange of genetic information;
bivalents arranged independently;

2 max

(ii) separation / spliting / pulling apart of homologous chromosomes / pairs of chromosomes;

(must give indication that one chromosome moves to each side)
(must be in the context of meiosis – not chromatid movements and not chromosomes separate)

pulled at centromere / by spindle / fibres;

2

(c) (i) the short arm of both chromosomes labelled on the middle homologous pair;

*(**B** and **b** must be labelled on separate chromosomes)*

1

(ii) 8 = 2 marks;
working showing genotypes with 1 allele from each pair
(for example, **B C D**) = 1 mark

2

[8]

M13. (a) (meiosis) anaphase I;
chromosomes are moving apart;
chromosomes still double structures;

3

(b) chromosomes in each (homologous) pair twist around each other;

chromatids break and rejoin to chromatid on sister chromosome;

(accept points from a suitable diagram)

2

[5]

M15. (a) high energy radiation / ionising particles;
named particles / α, β, γ;
colchicine;
x rays / cosmic rays;
uv (light);
carcinogen / named carcinogen;
mustard gas / phenols / tar (qualified);

1 max

(b) (i) removal of one or more bases / nucleotide;
frameshift / (from point of mutation) base sequence change;

2

(ii) sequence of bases in mRNA would change;
(sequence of) amino acids different / different primary structure;
(active site / enzyme 1) changed tertiary shape / changed active sites;
white pigment does not bind;
lilac pigment not produced / white pigment remains unchanged / enzyme 1 does not function;

4 max

[6]

M17.(a) (No – no mark)

Graph / bar chart only shows number of species, not the name of the species;

1

(b) (No – no mark)

1. Mutations are spontaneous / random;
2. Only the rate of mutation is affected by environment;
3. Different species do not interbreed / do not produce fertile offspring;
4. So mutation / gene / allele cannot be passed from one species to another;

Ignore references to correlation does not prove causation

4

(c)
1. Initially one / few insects with favourable mutation / allele;
2. Individuals with (favourable) mutation / allele will have more offspring;
3. Takes many generations for (favourable) mutation / allele to become the most common allele (of this gene);

3

[8]

M19. (a) (So results) can be compared / so measurement is the same each time / because eye is not perfectly round / uniform;

Accept eye opens to different amounts

1

(b) (i) 1. Eye (diameter) is smaller and antennae longer;

2. Antennae detecting touch;

3. Data only refers to shrimps / data may not apply to all animals / only in one area;

The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.

2 max

(ii) 1. Standard deviation gives a measure of spread / variation;

2. More standard deviations overlap, the less likely it is that differences are real / significant / the more likely they are caused by chance;

Do not accept range

Accept converse.

Although we are looking for the idea of significance, we cannot require this term.

2

(c) (i) Qualitative statement about

difference in size /

difference in variation /

overlap in size;

Quantitative statement about

difference in size /

difference in variation /

overlap in size;

Supported by relevant two sets of figures from graph;;

Note simplistic answer involving a quantitative statement gains 1 mark.

More specific answer involving quantitative information gains 2 marks.

2

(ii) (No) for same body length, antenna are longer / antenna are shorter / some with longer body have short antennae / some with shorter body length have longer antennae;

OR

(Yes) positive correlation in open / in cave;

Habitat not critical as a term.

Must refer to idea of same habitat

Accept description

1

(d) More alleles of each gene / shrimps in open have all the alleles;

Candidates are required to use the information from the table. Must therefore refer to alleles.

1

(e) 1. A small number of shrimps were / went into the cave;

2. All / high proportion of shrimps had allele L;

3. Cave population descended from these / these reproduce;

3

(f) (i) 1. Cross shrimps from two sites / watch courtship;

2. Breed young together / observe mating;

3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses / large number of crosses / isolate beforehand;

Other valid equivalent suggestions should be accepted.

(ii) If same species the shrimps would breed, producing fertile young / courtship species specific;

Accept any form of evidence – mating / laying eggs / giving birth to young.

3

[15]

M21. (a) (i) Antibiotics kill other bacteria / *Clostridium* is resistant;

Less / no competition so (*Clostridium*) reproduces / replicates / multiplies / increases in number;

Reference to bacteria being 'immune' negates first marking point.

Reference to mitosis negates second marking point.

2

(ii) Immune system less effective / more likely to have other infections / been in hospital;

Accept: 'Weak / lower' immune system'.

1

(b) Attaches to active site (of enzyme);
(Methicillin) is a competitive inhibitor / prevents monomers / substrate attaching (to enzyme);

'Competes for active site' = 2 marks.

Neutral: 'Prevents monomers joining / attaching to each other'.

Allow one mark max for answers relating to non-competitive inhibitor changing active site / preventing substrate attaching.

Do not penalise Methicillin forms an enzyme / substrate complex.

2

(c) (i) Have other illness / medical condition / 'weak' immune system / disease / infection;

Reject: Due to 'other factors', 'are smokers', 'are obese' unless related to disease or illness.

1

(ii) Increase up to 2006 / 20 (per 100 000) then decreases;

1

(iii) Correct answer in range of 52 – 59.1% = two marks;

Incorrect answer but shows change as between 4.8 – 5.2 / shows correct subtraction giving this change e.g. 14 – 9 = one mark.

2

[9]

M23. (a) Isolation / quarantine / 'kept separate';

Screening / testing (of patients / doctors etc);

Sterilisation of wards / equipment / method to improve hygiene;

Do not allow improve 'hygiene' or 'cleanliness' without named example such as 'washing hands' use of gloves etc.

2 max

(b) May not all be absorbed;

May be broken down / metabolised / excreted quickly;

To kill the microorganisms / bacteria;

Reference to antibiotic resistance;

Reference to becoming 'immune' negates last marking point.

2 max

(c) (i) P;

1

(ii) S;

1

(d) (i) Prevents bias;

Vested interest (of scientists);

Prevents 'placebo' / positive / negative / psychological effects / 'demand characteristics' (in volunteers);

2 max

(ii) Age;

Ethnicity;

Lifestyle;

Body mass;

Health;

Sex of person;

Ignore references to same or different

2 max

(e) Gradual / slight increase followed by rapid / greater increase;

Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.

1

[11]

M25. (a) 1. frequent use of antibiotic creates selection pressure / antibiotic kills bacteria;
2. bacteria with mutation / resistance have (selective) advantage over others / described;
3. (survive to) reproduce more than other types pass on advantageous allele / mutated allele in greater numbers;
4. frequency of (advantageous) allele increases in subsequent generations;

(penalise use of “gene” instead of allele once only)

5. frequency of resistant types increases in subsequent generations;

5

(b) correct answer = 0.18;
And three marks for three of:
$p + q = 1$ and $p^2 + 2pq + q^2 = 1$;
$0.01 = q^2$;
$q = 0.1$;
$p = 0.9$
frequency of heterozygotes = $2pq = 2 \times 0.1 \times 0.9$ / 2 × candidates
p × candidates q;

4 max

[9]

M27. (a) group of organisms with similar features;
can (interbreed to) produce fertile offspring;

2

(b) directional selection;
any TWO from
selection against one extreme / for one extreme;
against broadest beaks in B and narrowest beaks in **A** / for narrowest in **B** and broadest in **A**;
whole distribution / range / mean / mode / median is shifted towards favoured extreme;

3 max

[5]

M29. (i) increased use of insecticides / greater selection pressure;

1

(ii) mutations;
producing alleles / genes giving resistance;
natural selection / described leads to increased frequency of alleles / genes in population / insect;

3

[4]

M31. (a) mutation produced (allele / gene for) resistance;

(reject mutation as a result of pesticide)

variation within insect population /
some insects able to survive application;
reproduce;
pass on alleles / genes;

3

(b) pesticide is lipid soluble;
membranes contain lipid / phospholipid;
OR
pesticide fits into receptors / proteins on membrane;
passes through carrier proteins / facilitated diffusion / active transport;

(points must be linked)

2

[5]

M33. (a) 2 of the following pairs:

Mark for explanation must be paired with correct change in structure

1. Larger leaves;
2. Photosynthesis;

OR

Accept converse descriptions of leaves, root and stem: longer root, taller stem, smaller leaves

3. Larger / bigger / thicker root;
4. Storage;

OR

5. Stem shorter / absent;

   Accept converse correct explanation

6. Less energy used in stem growth / more energy for producing sugar;

4 max

(b) Beet ready quicker / less time required / allows land to be used again / harvested earlier;

Allow more crops / many harvests. Ignore references to yield / profit

1

(c)
1. (Diversity) reduced / fewer different alleles / less variation / smaller gene pool;
2. As alleles have been chosen / rejected;

2

[7]

M35. (a) description of interspecific competition / competition between species / birds with beaks of different lengths;
link length of beaks to different positions of prey / reference to named bird with particular prey e.g. curlews with longer beaks able to feed on ragworms;

2

(b) variation in beak length in curlews / one species;
longer / more curved beaked curlews outcompete / at advantage / suggested advantage e.g. larger / curled beaks access more food;
reproduction;
genes passed on (to offspring);

4

(c) body has lower water potential;
water diffuses along a water potential gradient / by osmosis;

2

[8]